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Modeling of Automatic Rotating Door Using Pneumatic and Sensors

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***Abstract*—Automatic pneumatic door using photoelectric sensor serves to automate the mechanism of door operation using Pneumatic and photoelectric sensor technology. The methodology applied in the project is divided into two parts, firstly designing and fabrication of the door with the calculated dimensions, secondly, interfacing the different components to work together in a cohesive manner. When an object comes in or goes out of the range of the sensor, a signal is sent to the Solenoid valve which controls the electro-pneumatic circuit to open or close the door. The significance of this system is automation of the door which can be customized according to the industrial, commercial or domestic requirements. Based on the results obtained a modal is designed and a suitable code was developed taking into account the ambient light conditions.**

Index Terms— automatic rotating door

I. Introduction

Automation, as defined by the Automation Federation, is the creation and application of technology to monitor and control the production and delivery of products and services." With respect to doors, Automation is generally reserved for two purposes, accommodating high flows of pedestrian traffic and providing accessibility for people with disabilities. In this project, we will briefly discuss the various fields incorporated in our project, objectives, motivation, the work schedule and the organization of the report.

The automatic pneumatic door consists of a rotating mechanism which is pneumatically operated, uses photoelectric sensors to serve as input and a solenoid valve to provide the required logic. The project incorporates the various fields, viz., Pneumatics, Microcontrollers, Sensor Technology and Carpentry, to ensure smooth and hassle free door operation. Pneumatics is a branch of technology that deals with the study and application of pressurized gas to effect mechanical motion. In this system a centrally located and electrically powered compressor is used that powers cylinders and other pneumatic devices through solenoid valves.

II. Methodology

A. Design of Pneumatic System for Door

First, our team analysis the proper of the door and saw that we have to rotate the door and we proper scaling the door and analysis the door and we found that it is made of glass and stain wood and framing by aluminium.

The wooden frames are made up one wood & glass pieces which are initially cut into approximate length and planned to get a smooth and parallel surface. The two pieces are joined in such a way that it forms a rectangular shape in order to accommodate single doors.

One piece of wood & glass are used as stand so that the door frame can be clamped inside it and the door doesn‘t topple. The four frames are joined together using four screw joints. Then glue and nails are used to clamp the joints together and increase the strength of the dovetail joints.

B. Force & Torque Analysis for Door

The door made glass and satinwood and framing by aluminum and the door fixed by three hinged support and proper dimension by the scale measurement. Analysis of the minimum force required for the rotating the door and torque. We have calculated by applied of the mechanics and standard value by the table chart for easily calculated in this problem.

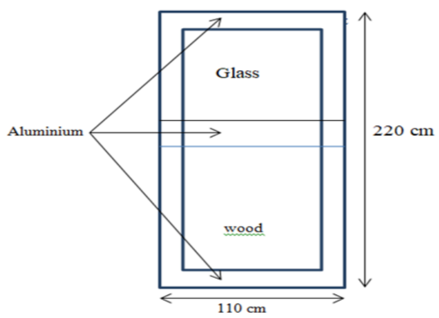

Fig. 1. Dimension of the door

For glass:
Length=94 cm
Height=112 cm
Thickness=5mm

For wood:
Length=94 cm
Height=80 cm
Thickness=5mm

Density of material used in the door:

ρ_G = 2.8 x 103 Kg/m^3 (Ordinary Glass)
ρ_{Al} = 2.7 x 103 Kg/m^3 (Aluminum)
ρ_w = 960 Kg/m^3 (Satinwood)

Calculation of mass of door:

Mass of Glass:

V_G = length x thickness x height
V_G = 0.94 x 0.005 x 1.12 m^3
V_G = 0.00526 m^3
$M_G = V_G \times \rho_G$ (1)
M_G = 0.00526 x 2.8 x 10^3
M_G = 14.728 Kg

Mass of wood:

V_W = length x thickness x height (2)
V_W = 0.94 x 0.005 x 0.8 m^3
V_W = 0.00376 m^3
$M_w = V_w \times \rho_w$ (3)
M_w = 0.00376 x 960
M_w = 3.61 Kg

Mass of aluminum:

V_{Al} = l x t x h (4)
V_{Al} = 1.1 x 0.005 x 2.2
V_{Al} = 0.0121 m^3
$V_{Al} = V_{Al} - (V_G + V_W)$ V_{Al} = 0.00308 m^3 (5)
M_{Al} = 8.32 Kg

Total mass of door (M_D) = $M_G + M_W + M_{Al}$ (6)
M_D=26.65 Kg

Force required to open the door at "30 cm" from rotational axis of the door
M_D=26.65 Kg
Force required to open the door at "30 cm" from rotational axis of the door.

$$\tau = F \times d \quad (7)$$
$$\tau = (m \times r \times \omega^2)d \quad (8)$$

d= Perpendicular between rotating axis of door to force exerted on the door)
r = Radius of circular path of the door
w = Angular velocity of the door.
d = turning angle of door.
τ = Torque

$$\tau = \left[m \times r \left(\frac{d\theta}{dt}\right)^2\right] \times d \quad (9)$$
$$\tau = \left[26.65 \times 1.1 \left(\frac{1.57}{5}\right)^2\right] \times 1.1$$

τ = 3.179 N-m

Force required to open the door at 30 cm from rotational axis of the door.
We know that torque will be same at free end and at 30cm from the rotational axis of the door

f x 0.3 = τ (τ = 3.179) (10)
f = 10.6 N

This force is exerted on the door at 30. So net force required to open the door

$$F_{Net}\, Sin30 = f \quad (11)$$
$$F_{Net} = \frac{10.6}{Sin30} = 21.2\ N$$

Let we assume, F_{OS}=2
Hence,

$$F_{OS} = \frac{F}{F_{Net}} \quad (12)$$
$$F = F_{OS} \times F_{Net} \quad (13)$$

F = 2 × 21.2
F = 42.4 N

Maximum force produce by the compressor

$$F_{Max} = P \times A \quad (14)$$

Where A is the area

$$F_{Max} = 8 \times 10^5 \times \frac{\pi}{4} \times (0.01)^2$$

F_{Max}= 62.83 N

Range of pneumatic system: 5.5 - 6.9 bar

C. *Pneumatic and Mechanical Component:*

1. Air compressor
2. Flow control valve
3. Pneumatic tube
4. Solenoid valve
5. Pneumatic filter
6. Photoelectric sensor
7. DC converter
8. Pneumatic cylinder

D. *Working*

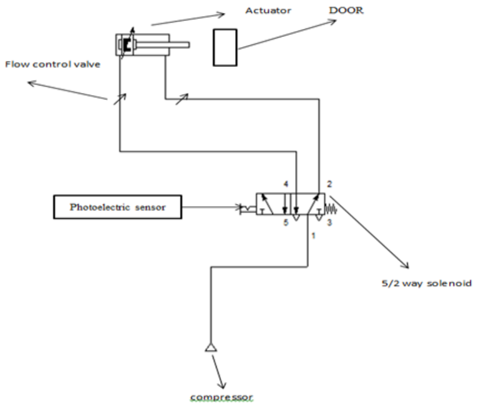

Fig. 2. Working of the model

1. Photoelectric senses an object and send the signal to the 5/2 solenoid.
2. 5/2 solenoid operates in such a way that it directs the compressed air from the compressor through the control valve to the actuator/double acting cylinder (dac).
3. This compressed air pushes the piston of double acting cylinder (DAC) which in turn rotate the door to open it.

4. Speed of rotation of this door can be regulating by flow control valve.
5. After a particular set time period, compressed air will flow from 2nd valve of 5/2 solenoid valve which forces the door to get closed.

III. Result

The door was fabricated in the robotics lab and calculation of door mass (m=27 kg) and maximum force required for open & closed door (f=62.83 N) and more sufficient of pneumatic cylinder length L=200mm and force generated and easily door open and closed. This method used of automation in door easily working, no more maintenance, electric energy save and more compact.

IV. Conclusion

After completing the project, conclude that our project is simple in construction and compact in size for use. Manufacturing of machine is easy and cost of the machine is less. Power consumption is low and easily used in solar power. In this device easily connect the mini solar power.

References

[1] Peter Croser and Frank Ebel, "Pneumatics - Basic Level," FESTO Handbook, 2002 Edition.
[2] Andrew Parr, "Pneumatic and Hydraulics," Second edition.
[3] Jagadeesha, "Pneumatic and Hydraulics."
[4] History of Automatic Doors. Source: www.edoors.com
[5] Festo (fluid SIM-P)-Design software.